

Remarks

Thorough examination by the Examiner is noted and appreciated.

The claims have been amended and new claims added to more clearly claim Applicants invention. Support for the amended and newly drafted claims are found in the original claims and/or the Specification. For example, support for limitations in amended claims 1 and 12 are found in the Specification at paragraph 0023:

"According the method of the present invention, it has been found that the addition of the preferred amounts of CO during the breakthrough etch process advantageously **promotes the formation of a hardened cross-linked shell 20A of photoresist** in a photoresist thickness (e.g., from about 10 Angstroms to about 100 Angstroms) adjacent the surface portion including sidewalls of the photoresist layer 20."

Paragraph 0026:

"Referring to Figure 1D, following the breakthrough plasma assisted etch (e.g., RIE) process including a predetermined amount of CO **to simultaneously accomplish a CO plasma treatment of the photoresist layer 20 and a breakthrough etch process, a conventional plasma chemistry is used in a second plasma assisted etch process** (e.g., RIE) to etch through a thickness portion of the IMD layer 14B, for example, stopping on etch stop layer 12B to form trench opening 18C overlying and encompassing via opening 18A."

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Paragraph 0028:

"It has been found, according to exemplary embodiments of the present invention that the **dimension of the upper portion of a via and/or trench openings may be selectively controlled** over a range of about 5 nanometers to about 25 nanometers by controlling the amount of CO added to the breakthrough etching chemistry over a range of about 3% to about 20% by volume of the etching chemistry total gas volume."

"For example, the CD bias of the opening level **may be increased or decreased**, depending on the amount of CO added to the breakthrough etching chemistry over a range of about 2% to about 10% of the opening linewidth or diameter."

Support for remaining amendments is found elsewhere in the Specification and/or the original claims. No new matter has been entered.

#### **Claim Rejections under 35 USC 112**

Claims 7 and 18 stand rejected under 35 USC 112, as being indefinite. Applicants have amended the claims to overcome Examiners rejection.

#### **Claim Rejections under 35 USC 103(a)**

1. Claims 1-4, 6-9, 12-15, and 17-19 stand rejected under 35 USC 103(a) as being unpatentable over Chu et al. (US 2004/0192058) in view of Liu et al. (US 6,613,689).

**Statement of Common Ownership Pursuant to 35 USC 103(c)**

Applicant's attorney of record state that Chu et al. (US 2004/0192058) and Applicants instant application were, at the time the invention was made, owned by Taiwan Semiconductor Manufacturing Company. Therefore, Examiners use of Chu et al. as a reference in a 103(a) rejection appears to be improper under 35 USC §103(C).

However, while not agreeing Chu et al. may be properly be used as a reference in a rejection under 103(a), assuming *arguendo* that it is a properly used reference, Applicants respectfully traverse Examiner's rejection under 35 U.S.C. 103(a). Chu et al. disclose a process whereby a CO containing **plasma treatment** of a patterned photoresist is carried out **prior to an etching process** to increase an etching resistance of the photoresist, **followed by an etching process** (see e.g., Abstract, Figure 3).

Nowhere do Chu et al. disclose or suggest a process whereby an opening upper portion critical dimension is controlled by first plasma etching through an uppermost BARC layer with a plasma etching chemistry comprising CO to both increase the patterned photoresist etching resistance **and** controllably producing a critical dimension of an opening upper level.

Nowhere do Chu et al. disclose or suggest:

"A method for selectively etching a semiconductor feature openings to controllably adjust a critical dimension comprising an upper portion of a feature opening", including "carrying out a first plasma assisted etching process to etch through a thickness of the BARC layer comprising a predetermined amount of CO in a first plasma etching chemistry to form a predetermined critical dimension of a second opening upper portion including forming a hardened shell comprising the photoresist at the photoresist layer surface, said hardened shell having an increased etching resistance; and, carrying out a second plasma assisted etching process comprising a second plasma etching chemistry to etch through a thickness portion of the at least one dielectric insulating layer to form the second opening."

Liu et al., on the other hand, disclose a process whereby an oxide etching process is carried out in the presence of a magnetic field using preferred fluorine/carbon ratios to control a polymer deposition rate to thereby achieve a desired sidewall etch profile (see Abstract; col 5, lines 40-56; col 7, lines 65 - col 8 line 5). The principal of operation of the method of Liu et al. is to deposit a polymer **during etching of the dielectric insulating layer** to both increase photoresist selectivity as well as controlling an etch profile of an opening formed in an oxide dielectric insulating layer (col 8, lines 6-19). Further, CO is disclosed as a much less preferred additive, as an alternative to

oxygen, that is used to control a polymerization rate along with an F/C ratio of an oxide (dielectric insulating layer) etching chemistry. Liu et al. teach that CO is not preferred since it produces a more complex polymer (col 6, lines 12-14) and moreover, actually teach and claim a process where no CO is present (col 10. lines 50-54), thereby teaching away from Applicants disclosed and claimed invention.

Liu et al., further do not disclose Applicants disclosed and claimed two step etching process including first etching through a BARC layer with a CO containing plasma chemistry and then etching through a dielectric insulating layer using a second plasma etching chemistry. Nowhere do Chu et al. or Liu et al. recognize the problem, or disclose a process capable of providing a solution to the problem, that Applicants have recognized and solved by their disclosed and claimed invention:

"A method for selectively etching a semiconductor feature openings to controllably adjust a critical dimension comprising an upper portion of a feature opening"

There is no apparent motive for combining the teachings of Chu et al. and Liu et al. The principal of operation of Chu et al. works by a different principal of operation than the method of Liu et al. In the method of Chu et al., a **CO plasma treatment**

is carried out **prior to** a plasma etching process, whereby the photoresist etching resistance is increased by forming a hardened cross-linked photoresist shell at the surface of the photoresist, rather than **depositing a polymer over the photoresist during the dielectric insulating layer etching process** as taught by Liu et al. Modifying Chu et al. with the teachings of Liu et al. would destroy the principal of operation of both the methods of Chu et al. and Liu et al., making either process unfit for its intended purpose.

Moreover, even assuming *arguendo* proper motivation for such combination, combining the teachings of Chu et al. and Liu et al. does not produce Applicants disclosed and claimed two-step etching process.

"The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." *In re Ratti*, 270 F.2d 810, 123, USPQ 349 (CCPA 1959).

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"If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification." *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

2. Claims 5 and 16 stand rejected under 35 USC 103(a) as being unpatentable over Chu et al. in view of Liu et al., and further in view of Tsai (US 6,787,445).

Applicants reiterate the comments made above with respect to Chu et al. and Liu et al.

The fact that Tsai teaches an ashing process using CF4 and oxygen for removing photoresist does not help Examiner in establishing a *prima facie* case of obviousness.

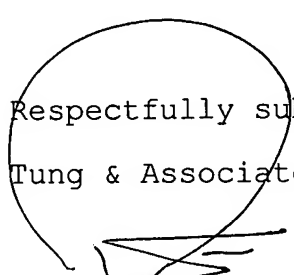
The Claims have been amended to clarify Applicants' invention. A favorable consideration of Applicants' claims is respectfully requested.

Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

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In the event that the present invention as claimed is not in condition for allowance for any reason, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,  
Tung & Associates



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Randy W. Tung  
Reg. No. 31,311  
Telephone: (248) 540-4040